ECE 321: Handout #10

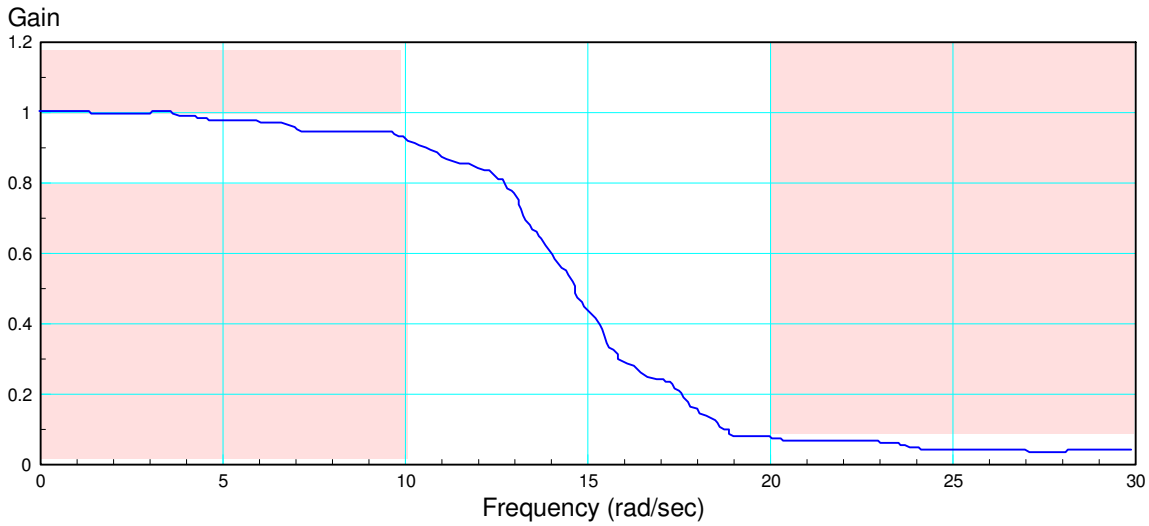
Fitler Design

Design a low-pass filter to meet the following specifications

- DC gain = 1.000
- 0.9 < gain < 1.0 for frequencies below 10 rad/sec
- gain < 0.1 for frequencies above 20 rad/sec

a) Determne the number of poles needed

b) Give the transfer funciton of a Butterworth filter which should come close to meeting these requirements



Solution

The number of poles needed are

$$\left(\frac{10\frac{rad}{\sec}}{20\frac{rad}{\sec}}\right)^n < 0.1$$

$$n > 3.322$$

Let n = 4. A 4th-order Butterworth fitler with a corner at 1 rad/sec is

$$G(s) = \left(\frac{1}{\left(s+1\angle\pm 22.5^0\right)\left(s+1\angle\pm 67.5^0\right)}\right)$$

A 4th-order Butterworth filter with a corner at 12 rad/sec is

$$G(s) = \left(\frac{12^4}{\left(s+12\angle\pm 22.5^0\right)\left(s+12\angle\pm 67.5^0\right)}\right)$$

12 is just a guess:

- Something more than 10 and less than 20
- I'd have to use matlab to itterate from here

```
>> w = [0:0.15:30]';
>> p1 = 12*exp(j*22.5*pi/180);
>> p2 = conj(p1);
>> p3 = 12*exp(j*67.5*pi/180);
>> p4 = conj(p3);
>> s = j*w;
>> G = 12^4 ./ ( (s+p1).*(s+p2).*(s+p3).*(s+p4) );
>> plot(w,abs(G))
>> plot(w,abs(G),10,0.9,'x',20,0.1,'x')
>
```